ISSN 2229-5518

Effect of Different Rates of Phosphate Fertilizer (OCP) On Post-Harvest Deterioration of Eggplant

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Abstract— The aim of the study was to determine the effect of different rates of phosphate fertilizer (OCP) application on the post-harvest deterioration of Eggplant in terms of how long it can last after harvesting. A plot size of 200 m2 was used for the experiment with each treatment measuring 2m x 5m in a randomized complete plot (RCBD) design with four treatments (300 kg/ha, 250 kg/ha, 150 kg/ha, and Control) and replicated three times, summing up to 16 plots. Growth data, as well as yield and yield components, were taken on (plant number of leaves, plant height, and yield), as the number of days it will take each treatment to deteriorate (spoil) after harvesting. Data were subjected to the GenStat computer software package. It was observed from the experiment that, the 300 kg/Ha treatment recorded the highest figure in terms of the growth rate parameters than the other treatments, and was closely followed by the 250 kg/ha treatment. This was also realized in the yield that was recorded with the 300 kg/ha treatment producing the highest value. However, the treatment effect on the postharvest parameter was not significant.

Index Terms— Eggplant, Phosphate fertilizer, Post-harvest deterioration, and Rate of application

1 INTRODUCTION

Eggplant (Solanum aethiopiecum) is a highly adaptable and highly productive crop grown in both tropical and subtropical regions (Sidhu et al., 2014). It is among the 30 commonly produced and consumed horticultural crops worldwide (Concellon et al., 2007; Florkowski et al., 2014). The eggplant fruit is ovoid or spherical with a light green calyx and a firm texture (Gross et al., 2014; Jha & Matsuoka, 2002). It is of high nutritional and economic importance (Cortbaoui et al. 2015; Okmen et al., 2009). Commonly known as garden eggs in Ghana, it is an important vegetable crop that serves as a source of income for farmers and vendors. It is rich in polyphenols, vitamins, and minerals that provide a variety of health benefits, including valuable antioxidant, anti-inflammatory, and anti-cancer properties (Cortbaoui et al., 2015).

The aubergine, also known as eggplant, brinjal, or guinea squash, is one of the non-tuberous species of the nightshade family Solanaceae. The cultivars show a wide range of fruit shapes and colors, from oval or ovate to oblong club-shaped; and from white, yellow, and green through degrees of violet pigmentation to almost black. It is an economically important crop in Asia, Africa, and the subtropics (India, Central America) and is also grown in some warm-temperate regions of the Mediterranean and South America (Sihachkr et al., 1993). Eggplant fruits are known to be low in calories and have a mineral composition beneficial to human health. Eggplant is among the top 10 vegetables in terms of its ability to absorb oxygen radicals. They are also a rich source of potassium, magnesium, calcium, and iron. The yield depends on several production factors. The right, balanced diet plays a major role in this. Nitrogen is considered one of the essential macronutrients that plants need for their growth, development, and yield (Singh et al., 2003). Two other cultivated eggplant species, the scarlet eggplant, and the Gboma eggplant are lesser known but have local importance in sub-Saharan Africa. Based on 2014 data, the global production of eggplant is around 50 million tons annually with a net worth of more than US$10 billion per year, making it the fifth most economically important nightshade crop after potatoes, tomatoes, peppers and tobacco (FAO, 2014). The top five producing countries are China (28.4 million tons; 57% of the world total), India

(13.4 million tons; 27%), Egypt (1.22 million tons), Turkey (0.82 million tons) and Iran (0.75 million tons In Asia and the Mediterranean region, the eggplant is one of the top five vegetable crops.

Eggplants are berry-producing vegetables in the large Solanaceae (nightshade) family, which includes about 3,000 species distributed in about 90 genera. Of these, Solanum is the largest with around 1,500 species, including important global crops such as potatoes and tomatoes, as well as many other smaller crops. Most taxa of the genus Solanum have a basic chromosome number of n=12 (Chiarini et al., 2010). Despite these benefits, eggplant fruit is highly perishable and its phenolic content can be affected by poor post-harvest handling practices (Agarwal et al., 2012). Excessive post-harvest fruit loss is a major problem in Africa. In Ghana, for example, farmers and vendors watch helplessly as their produce is wasted, causing financial losses and depriving consumers of much-needed food and nutrients. Kitinoja & Cantwell (2010) estimated the post-harvest losses of eggplant crops in Ghana to be 13.9% on farms, 11.3% in the wholesale market and 16.2% in the retail market. Eggplant fruits in Ghana are usually left at ambient conditions, causing undesirable color changes and weight loss, causing the fruit to shrivel and become unacceptable for sale and consumption. Factors contributing to fruit spoilage after harvest include high respiration rates, moisture loss, and the activity of microorganisms.

In countries like Ghana, high tropical temperatures and agronomic practices also help to accelerate fruit aging by accelerating spoilage responses and promoting microbial growth (Snowden, 2008). Nutrients are used primarily with the aim of maximizing profits. Profit is represented by the difference between the value of the yield increment resulting from the cost of applying the nutrients and the harvest of the increment (Collins et al., 1955). In order to get the full effect of the nutrient supplied, it is not only important to use the correct nutrients, but also to supply the nutrient in the recommended amount and at the right time; and this is particularly important in the case of aubergines since the yield is better when fertilizers are applied at recommended rates (Jacob and Uexkull et al., 1988). However, since the individual nutrients fulfill different functions in the plant and are therefore not always needed at the same time and have different nutrient absorption capacities, it is difficult to set up general rules as to when certain nutrients are used in certain crops (Jacob and Uexkull et al., 1988). OCP Group is a Moroccan company that produces a range of enriched fertilizers that can be tailored to the needs of specific soil types, even down to individual fields. (Reuters. March 4, 2019. Retrieved April 22, 2020). They have released a new type of phosphate fertilizer formula in a ratio of NPK 11:22:21. This fertilizer has not been tested on several crops, including eggplant, making it difficult for farmers to determine its application rate. The main aim of the study was to improve eggplant production through the use of (OCP) fertilizer, specifically to evaluate different application rates of phosphate fertilizer (OCP) on the growth and yield of eggplant and to determine the effect of (OCP) fertilizer on fruit quality of eggplant.

2 MATERIALS AND METHODS

2.1 Study Area

The field experiment was conducted in the vegetable garden (Kwadaso Agricultural College Campus Nzema) in the Kumasi Metropolitan Assembly. The area is approximately 6 to 7 km from Kumasi CBD. The area lies within latitude 06 40N and longitude 01 40W. The soil is typical of the Ochrosol series with typical climatic conditions. Soils in Kwadaso are classified as well-drained, sandy clay loam with a moderately coarse texture. The pH of the soil is between 5.0 and 5.5, which is good for the proper growth and development of the eggplant. A randomized complete block (RCBD) design was used for the study. The experiment was twofold: in the first phase, the effect of (OCP) fertilizer on eggplants was studied, and the second part of the experiment was to study the effect of different rates of P fertilizer (OCP) application on spoilage (deterioration) of the fruits of the eggplant. Fieldwork, the seeds were sourced from Crops Research Institute (Fumesua) in the central part of

Ashanti region and it is the main eggplant-growing city in the country with more than 1000 hectares of eggplant farms cultivated annually.

2.1 Experimental Site and Treatments

A plot size of 13.0 x 17.5 m was cleared and beds of 2 x 5 m each were created. The seedlings were transplanted when they were about 4 weeks old. The seedlings were watered prior to uprooting for transplanting to soften the soil for easy lifting. The seedlings were planted at a depth of 2 cm and watered immediately after transplanting. Plants were spaced 60 cm x 60 cm with a total of 10 plants per plot size of 2 m x 5 m. Four treatments (300 kg/ha, 250 kg/ha, 150 kg/ha, and control) were repeated three times. The fertilizer was sourced from the OCP Group's headquarters in Accra, near the airport residential area. The fertilizer reformulated in the ratio NPK (11:22:21) was applied once at rates of 300 kg/ha, 250 kg/ha, and 150 kg/ha two weeks after transplanting. Treatments were randomly assigned to beds. Performed cultural practices included; Hand weeding, stirring, spraying pesticide when needed, and applying water daily.

2.1 Data Collection

Harvesting took place in three months, three weeks after planting. The eggplant fruit was picked during harvest and stored in a cool, dry place. Data Collected five plants were marked and data taken from them as follows; Plant height at weekly intervals for five weeks: This was measured with a ruler from soil level to leaf tip. A number of leaves at weekly intervals for five weeks: This was done by counting the number of leaves produced per plant. Fruit fresh weight at harvest for each treatment.

50 fruits were randomly selected from each treatment, which was carefully observed daily for 30 days to determine the number of days the fruits deteriorated and the number of fruits that deteriorated. All data were analyzed for analysis of variance and treatment differences were determined by the Lesser Significant Difference (LSD) method.

3. Results and Discussions:

Table 1: Plant height of treatments at different sampling days.

Treatment	Week 1	Week 2	Week 3	Week 4	Week 5
150kgP/Ha	7.467^{ab}	9.33^{ab}	12.36^{a}	16.07^{ab}	23.07^{a}
250kgP/Ha	8.740^{b}	10.99^{b}	13.59^{ab}	16.99^{ab}	22.33^{a}
300kgP/Ha	5.25^{c}	13.64^{c}	16.90^{b}	20.27^{b}	25.33^{a}
Control	5.787^{a}	7.69^{a}	26.42^{a}	13.73^{a}	19.53^{a}
P-value	<.001	0.001	<.001	0.015	0.151
L.s.d	1.789	1.834	2.810	3.947	4.999
S.e.d	0.893	0.916	1.403	1.970	2.495

From the table above it can be seen that there was a significant difference (p=<0.001) between each treatment, with the control having the lowest mean value while the 300 kg/ha had the highest mean plant height value. At weeks four and five there was no significant difference between 250 kg/ha and 300 kg/ha. However, at week five there was no significant difference between the treatments. According to Follett et al. (1981), the accuracy of predicting crop response to P fertilizer application in most soils is often questionable because of the minimal availability of native P to many crops and the fixation of fertilizer P in the soil. This might be the reason why the control treatment recorded the lowest mean value in all the growth and yield parameters measured.

Phosphorus deficiency is one of the largest constraints to crop production in many tropical soils, owing to the low native content and high P fixation capacity of the soil. In soils that are relatively low in P, eggplant growth and yield can be enhanced by applied P (Alt et al., 1999). According to the authors, no significant difference observed between the treatment during the fourth and fifth week can be attributed lack of response to applied P to the eggplant

Table 2: Mean number of leaves of eggplant.

Treatment	Week 1	Week 2	Week 3	Week 4	Week 5
150kgP/Ha	4.533[b]	7.400[b]	9.53[ab]	13.40[ab]	20.13[ab]
250kgP/Ha	6.133[c]	8.933[ab]	11.27[bc]	15.67[b]	21.13[a]
300kgP/Ha	7.133[c]	10.867[c]	13.87[c]	16.40[b]	22.20[b]
Control	2.733[a]	4.600[a]	5.80[a]	8.13[a]	11.60[a]
P-value	<.001	0.001	<.001	<.001	0.007
L.s.d	1.080	2.036	2.888	4.189	6.55
S.e.d	0.539	1.016	1.442	2.091	3.27

There was a significant difference (p=<0.001) between treatments with the 300 kg/ha treatment having the highest average number of leaves, followed closely by the 250 kg/ha treatment, while the control had the lowest average number of leaves, as can be seen from the table above.

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Table 3: Mean fruit weight (Kg) of eggplant.

Treatment	Weight (Kg)
150kgP/H	1.667[a]
250kgP/H	2.533[b]
300kgP/H	3.267[b]
Control	1.167[a]
P-value	<.001
L.s.d	0.6052
S.e.d	0.2625

The 300 kg P/ha recording the greatest yield value was influenced by the treatment recording the greatest mean value for the growth parameters measured throughout the experiment. The greatest plant height and number of leaves indicated that the plants were more exposed to conditions necessary for photosynthesis than the other treatments and hence the increase in the yield observed. Fairhurst et al. (1999) observed that Phosphorus deficiency is one of the largest constraints to crop production in many tropical soils, owing to the low native content and high P fixation capacity of the soil. Accordingly, P fertilization is usually recommended in these regions. Phosphorus is essential for root development and when the availability is limited, plant growth is usually reduced. The movement of P in soils is very low and its uptake generally depends on the concentration gradient and diffusion in the soil near the roots. In Eggplant, P deficiencies reduce root and leaf growth, fruit size, and yield and can also delay maturation (Greenwood et al., 2001).

Table 4: Mean number of deteriorated fruits of eggplant.

Treatment	Week 1	Week 2	Week 3	Week 4	Week 5
150kgP/Ha	1.667[a]	4.333[a]	4.333[a]	4.667[a]	4.333[a]
250kgP/Ha	1.667[a]	3.333[a]	3.333[a]	4.667[a]	5.333[a]
300kgP/Ha	3.000[a]	5.333[a]	4.667[a]	5.667[a]	4.667[a]
Control	0.000[a]	2.333[a]	3.667[a]	5.000[a]	4.000[a]
P-value	0.1471	0.143	0.431	0.728	0.659

L.s.d	2.607	2.718	1.960	2.306	2.491
S.e.d	1.130	1.179	0.850	1.000	1.080

From the table above, there was no significant difference between the various treatments from week 1 to week 5. Their means were further separated using Tukey's multiple test key which shows that there was no difference between the treatments

Generally, the treatments did not significantly affect fruit deterioration. According to Azene et al. (2014), the effect of respiration, storage temperature, and relative humidity on fruits means that these factors must be well controlled during the postharvest phase. Indeed, under commercial conditions, most fruits are kept at low temperatures to enhance their storage life. According to Kader et al. (1989) and Smith et al. (1987) to further enhance the storage life and quality of fruits under low temperatures, techniques that involve the modification of the gas composition around fruits (controlled and modified atmosphere) have been developed. This involves reducing oxygen and increasing carbon dioxide concentrations. Controlled and modified atmosphere packaging has been combined with low temperatures to delay ripening, reduce physiological disorders, and suppress decay in many fresh fruits. Modified atmosphere packaging involves the packaging of perishable produce in an atmosphere that has been modified so that its composition is other than that of air whereas controlled atmosphere storage involves maintaining a fixed concentration of gas around the product by careful monitoring and addition of gases when necessary (Coles et al., 2003).

Kaynas et al. (1995) found that the storage life of eggplant fruits can be extended up to five to six weeks for 42 days when stored at 12 °C and 90-95 % RH using controlled atmosphere storage. Benitez et al. (2013) also studied the effect of postharvest modified atmosphere packaging on the quality of eggplant fruits and found that modified atmosphere packaging was effective in delaying shriveling, reducing weight loss, improving visual quality, and extending shelf life.

4. CONCLUSION

The results showed that the 300 kg/ha treatment recorded the greatest in terms of growth rate parameters than the other treatments, whilst the control treatment produced the least. This was also realized in the yield that was recorded with the 300 kg/ha treatment producing the highest yield. However, the treatment application did not affect the postharvest parameter. From the experiment, it is recommended that phosphate fertilizer at a rate of 300 kg/ha improved the growth and yield of eggplant and therefore can be used to ensure efficient production by smallholder farmers. Other works can be carried out on the nutrition composition of eggplant using the same rates of P fertilizer.

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